Final Report
Space Physics Data Markup Language
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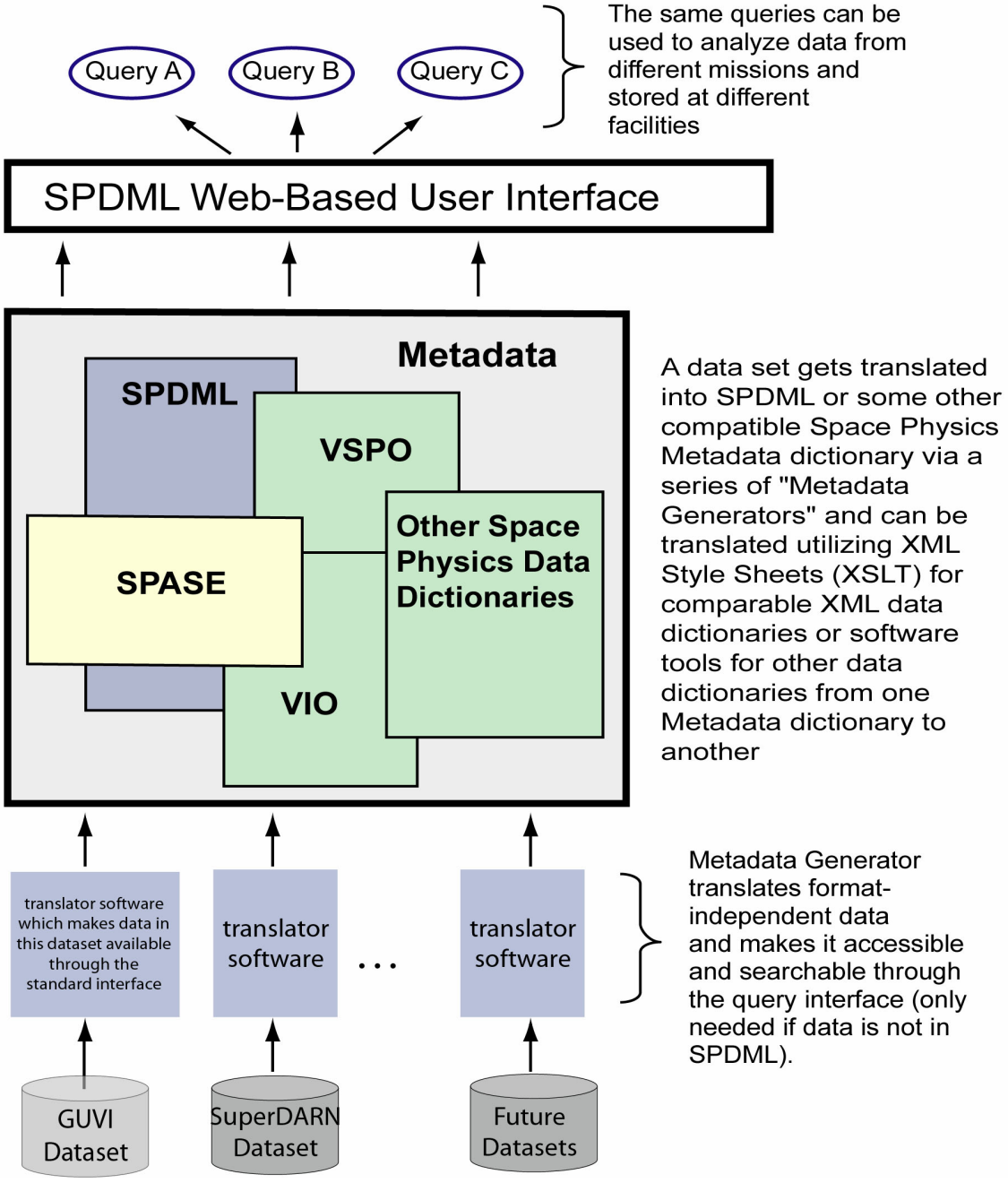
This report summarizes our activity on our NASA SR&T grant, "Space Physics Data Markup Language", NAG5-9432. In this AISRP we developed the Space Physics Data Markup Language (SPDML) which is an XML description language for the metadata for space physics datasets. We have developed a demonstration system using an ORACLE 9i database which contains SPDML metadata from the SuperDARN radar network, solar and geophysical indices, and instrument metadata from the TIMED spacecraft.

The metadata from the TIMED instruments is specialized and includes remote sensing field-of-view information. This allows highly evolved data queries such has "What data is available when the GUVI instrument on TIMED was observing the auroral oval and the SuperDARN radars were operating while the Kp index was greater than 5 at night?" These specialized queries are completely beyond the capability of current catalog systems available in space physics today and even exceed the capabilities of proposed future Virtual Observatories in the Sun-Earth-Connections environment. There are three important elements that have been developed under this grant which are illustrated below:

Step 1 - Data Dictionaries

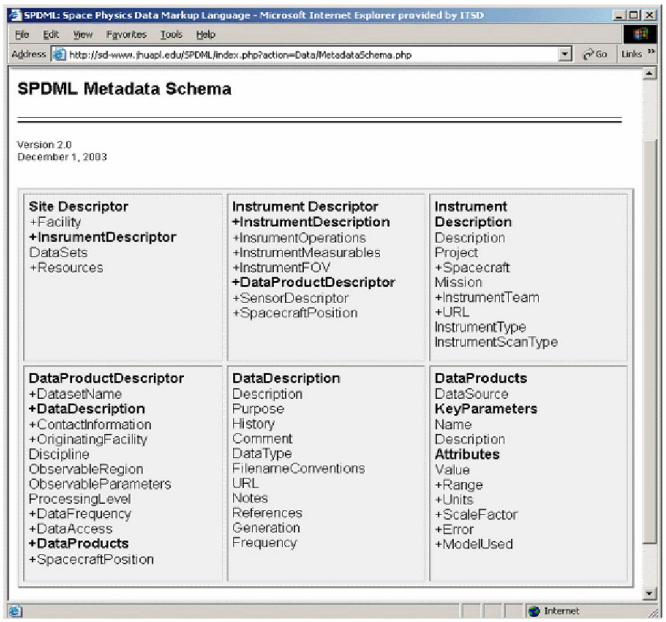
Widely disparate data sources that are remotely located make it very difficult for the user to find cross-mission data sets. SPDML provides a standard for expressing Space Physics metadata. It is based on SPASE, and has commonality with the VSPO data dictionary as well as other relevant Space Physics data dictionaries. Standards are the only way to make heterogeneous data sets accessible via a single and homogeneous manner.



Step 2 - Data Product Registry

The SPDML User Interface can only query on known Space Physics Data sets. To make a data product available, it must be registered with the SPDML Data Product Registry. The registry provides the means to identify and register all relevant data sets and associated data products and identifies the items in a data set that describe:

- a mission
- a spacecraft
- an experiment
- an instrument
- a data product
- physical discipline
- key parameters
- observable regions



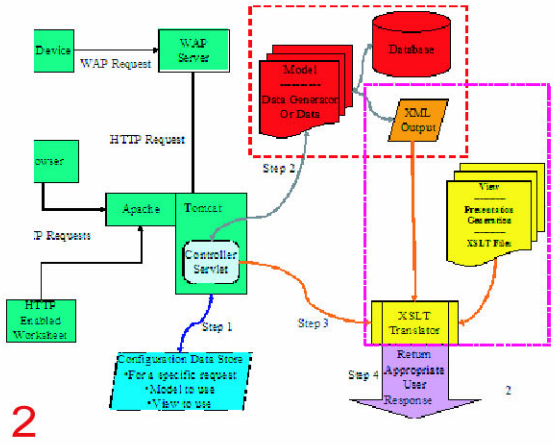
In addition, the data sets will be characterized by the following attributes:

- instrument type
- coverage time
- location of observation
- time
- solar zenith angle
- observed regime
- environmental characterizations

Step 3 - Query Interface

The Query Interface receives a set of user's input choices from the User Interface and assembles them into a complex query utilizing the information structure identified in the Data Product Registry. For our inital prototype, we are using Oracle 9i for the Query Interface.

```
SELECT
  extractvalue(VALUE(x),'//Mission'),
  extractvalue(VALUE(x),'//URL'),
  extractvalue(VALUE(x),'//DataProduct'
FROM SPDML x
WHERE (extractvalue(VALUE(x),'//Spacecraft') = 'TIMED'
       OR
       extractvalue(VALUE(x),'//Spacecraft') = 'GroundBased')
  AND (extractvalue(VALUE(x),'//Instrument') = 'SDI'
       OR
       extractvalue(VALUE(x),'//Instrument') = 'SuperDARN')
  AND extractvalue(VALUE(x),'//InstrumentMode') = 'Imaging'
  AND extractvalue(VALUE(x),'//ObservableRegion') = 'Ionosphere'
  AND extractvalue(VALUE(x),'//ObservablePhysicalParameters') = 'Density'
       OR
      extractvalue(VALUE(x),'//ObservablePhysicalParameters') = 'Flux'
       OR
      extractvalue(VALUE(x),'//ObservablePhysicalParameters') = 'Radiances' )
  AND extractvalue(VALUE(x),'//ProcessingLevel') = 'Derived'
  AND (extractvalue(VALUE(x),'//KeyParameters') = 'Characteristic Energy'
       OR
       extractvalue(VALUE(x),'//KeyParameters') = 'Cross Cap Potential')
  AND extractvalue(VALUE(x),'//StartDate') = '2003-03-30'
  AND extractvalue(VALUE(x),'//StartTime') = '00:00:00'
  AND extractvalue(VALUE(x),'//StopDate') = '2003-05-09'
  AND extractvalue(VALUE(x),'//StopTime') = '23:59:59'
```



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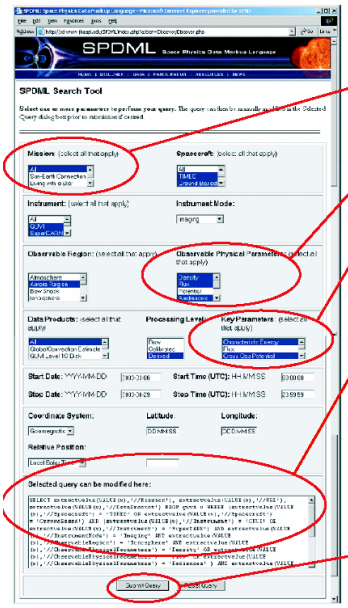
The user generates a query utilizing the User Interface which gets sent to the SPDML web server where the request is processed by querying the SPDML registryand database

In addition, for a demonstration system we have developed a user interface that allows you to make these detailed queries, display your results, and see a more detailed view of the metadata that you are searching.

User Interface

Provides a web-based, uniform and easily usable interface through which to query for and download any SPDML registered data sets including physically distributed data sets.

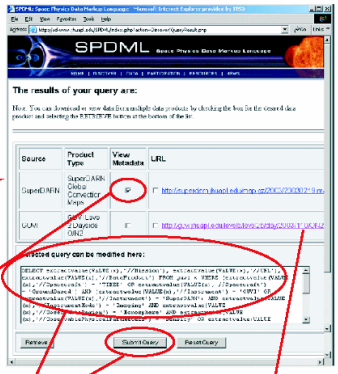
1. Search



Search items selected

Oracle query gets generated here and can also be manually modified here to support additional user criteria

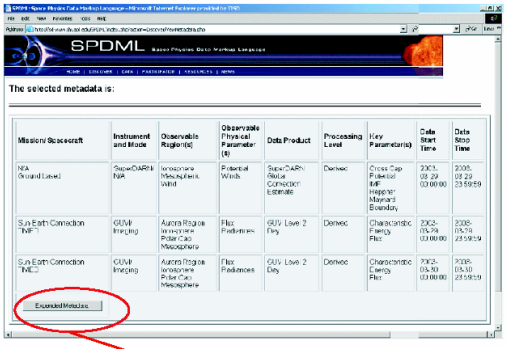
2. Results



Supports iterative refinement of query results

Download of files that match search criteria

3. View Metadata



More detailed metadata available

We have presented seven papers at scientific conferences about SPDML.

1. Morrison, Daniel, K. Heeres, T. Choo, J. Gersh, AISRP Investigators Workshop, Sep. 2000. "Space Physics Data Markup Language"
2. Morrison, Daniel, K. Heeres, T. Choo, J. Gersh, AISRP Investigators Workshop, Sep. 2001. "Space Physics Data Markup Language"
3. Weiss, M, Paxton, L, Barnes, R, Eichert, J, Wood, W, Morrison, D, Christensen, A, Strickland, D, Craven, J, Meier, R, Crowley, G, Avery, S, Meng, C, Strauss, P, Swenson, C, Waltersheid, R, Wolven, B C, *Eos Trans. AGU, 83(47), Fall Meet. Suppl., Abstract SA62B-0419, 2002*. "Exploiting Web-Based Systems to Provide Interactive Interpretation, Access and Display of Far Ultraviolet Data from the Global Ultraviolet Imager (GUVI) on TIMED"
4. Weiss, M; Morrison, D; Paxton, L; Barnes, R, *American Geophysical Union Meeting, April 6 - 11, 2003*. "Using XML to perform a web-based interrogation of large-scale Space Physics data sets focusing on TIMED and SuperDARN data"
5. Weiss, M, Morrison, D, Paxton, L, Barnes, R, *CEDAR Meeting June 15-20, 2003*. "Web-Based Space Physics Metadata Searching Using Space Physics Data Markup Language"
6. Weiss, M B, Morrison, D, Barnes, R J, and Paxton, L J, *American Geophysical Union Meeting, December 8 - 12, 2003*. "Space Physics Metadata Searching Using Space Physics Data Markup Language (SPDML)"
7. Weiss, M B, Morrison, D, Barnes, R J, and Paxton, L J, *CEDAR Meeting, June 27 – July 2, 2004*. "Space Physics Metadata Searching Using Space Physics Data Markup Language (SPDML)"

We are continuing to develop and evolve SPDML, our website, and our data catalog with internal funds at JHU/APL. Our web site from which our SPMDL specification and demonstration data querying capabilities is located at http://sd-www.jhuapl.edu/SPDML.